

WHAT IS CLAIMED IS:

5 1. A method of controlling a data transmission session by a sender to a receiver over a communications network, comprising:

receiving by the sender from the receiver via the communications network a plurality of data transmission acknowledgements;

generating by the sender a first connection rate estimate of network share using the plurality of acknowledgements; and

10 setting by the sender a data transmission control parameter using the first connection rate estimate.

2. The method of claim 1, wherein generating by the sender of a connection rate estimate further comprises:

15 generating a rate sample when an acknowledgement arrives using information in the acknowledgement regarding an amount of data received by the receiver data and an acknowledgement inter-arrival time; and

exponentially averaging the rate sample with a previous rate sample to produce smoothed rate estimate using a filter with time varying coefficients.

20 3. The method of claim 1, further comprising

generating a second connection rate estimate by the sender;

determining by the sender a cause of packet loss using the first connection rate estimate and the second connection rate estimate; and

25 setting by the sender a congestion window and a slow start threshold control parameter using the determination of the cause of packet loss.

4. The method of claim 3, wherein determining by the sender a cause of packet loss further comprises:

30 calculating a ratio of expected throughput to achieved throughput;

determining the cause of packet loss to be from congestion if the ratio exceeds a threshold value; and

determining the cause of packet loss to be from data transmission errors if the ratio of expected to achieved throughput is below the threshold value.

35 5. The method of claim 3, wherein the first connection rate estimate is a bandwidth estimate, the method further comprising:

generating a plurality of bandwidth samples using acknowledgment pairs taken from the plurality of acknowledgements; and

generating the bandwidth estimate using a low pass filter and the plurality of bandwidth samples

5

6. The method of claim 3, wherein the first connection rate estimate is a rate estimate, the method further comprising:

generating a plurality of rate estimates using amounts of data acknowledged during sampled time intervals; and

10

generating the rate estimate by applying a low pass filter to the plurality of rate estimates.

15

7. The method of claim 6, further comprising adapting the sampled time intervals using a perceived network congestion level, the perceived congestion level determined from a difference between an expected throughput and an achieved throughput of data from the sender to the receiver.

20

8. The method of claim 6, further comprising setting the congestion window and the slow start threshold during startup of a connection between the sender and the receiver over the communications network.

25

9. The method of claim 1, wherein the data transmission session is for video data, the method further comprising:

30

establishing a data connection between the sender and the receiver via the communications network;

establishing a data control connection between the sender and the receiver;

transmitting by the sender to the receiver video data via the data connection; and

receiving by the sender from the receiver the acknowledgements via data control connection.

35

10. The method of claim 9, wherein the acknowledgements include data control packets, the method further comprising:

determining by the sender a bandwidth estimate using the data control packets; and

altering by the sender a data transmission rate and a bitrate of the transmitted video

data.

11. A data processing apparatus for controlling a data transmission session by a sender to a receiver over a communications network, comprising:

a processor; and

5 a memory coupled to the processor, the memory having program instructions executable by the processor stored therein, the program instructions comprising:

receiving by the sender from the receiver via the communications network a plurality of data transmission acknowledgements;

generating by the sender a first connection rate estimate of network share using the plurality of acknowledgements; and

10 setting by the sender a data transmission control parameter using the first connection rate estimate.

12. The data processing apparatus of claim 11, wherein the program instructions for generating by the sender of a connection rate estimate further comprise:

15 generating a rate sample when an acknowledgement arrives using information in the acknowledgement regarding an amount of data received by the receiver data and an acknowledgement inter-arrival time; and

exponentially averaging the rate sample with a previous rate sample to produce smoothed rate estimate using a filter with time varying coefficients.

20 13. The data processing apparatus of claim 11, the program instructions further comprising

generating a second connection rate estimate by the sender;

determining by the sender a cause of packet loss using the first connection rate estimate and the second connection rate estimate; and

25 setting by the sender a congestion window and a slow start threshold control parameter using the determination of the cause of packet loss.

14. The data processing apparatus of claim 13, wherein the program instructions for determining by the sender a cause of packet loss further comprise:

30 calculating a ratio of expected throughput to achieved throughput;

determining the cause of packet loss to be from congestion if the ratio exceeds a threshold value; and

determining the cause of packet loss to be from data transmission errors if the ratio of expected to achieved throughput is below the threshold value.

35

15. The data processing apparatus of claim 13, wherein the first connection rate estimate is a bandwidth estimate, the program instructions further comprising:

generating a plurality of bandwidth samples using acknowledgement pairs taken from the plurality of acknowledgements; and

generating the bandwidth estimate using a low pass filter and the plurality of bandwidth samples

5

16. The data processing apparatus of claim 13, wherein the first connection rate estimate is a rate estimate, the program instructions further comprising:

generating a plurality of rate estimates using amounts of data acknowledged during sampled time intervals; and

10

generating the rate estimate by applying a low pass filter to the plurality of rate estimates.

15

17. The data processing apparatus of claim 16, the program instructions further comprising adapting the sampled time intervals using a perceived network congestion level, the perceived congestion level determined from a difference between an expected throughput and an achieved throughput of data from the sender to the receiver.

20

18. The data processing apparatus of claim 16, the program instructions further comprising setting the congestion window and the slow start threshold during startup of a connection between the sender and the receiver over the communications network.

25

19. The data processing apparatus of claim 11, wherein the data transmission session is for video data, the program instructions further comprising:

25

establishing a data connection between the sender and the receiver via the communications network;

establishing a data control connection between the sender and the receiver;

transmitting by the sender to the receiver video data via the data connection; and

receiving by the sender from the receiver the acknowledgements via data control connection.

30

20. The data processing apparatus of claim 19, wherein the acknowledgements include data control packets, the program instructions further comprising:

determining by the sender a bandwidth estimate using the data control packets; and

altering by the sender a data transmission rate and a bitrate of the transmitted video

35

data.